Space Weather Technical Forecast

Issued on Saturday, 13 April 2024 at 01:12 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/G2 Likely, peak Monday 15 April. Increased daily Chance of M-class X-ray flares.

Solar Activity: Solar activity fell to Low over the past 24 hours, with X-ray activity recorded at GOES16 and 18 showing occasional mid-ranking C-class activity, with a peak C8.9 flare at 12/1755UTC from an arriving region over the northeastern solar horizon.

There were five numbered sunspot regions on the disc in the period, with a pair of unipolar groups showing little change. The remaining three regions were bipolar, and changes within these were generally slow and slight. Observations included slight proliferation of surrounding small spots in AR3633; a spreading tendency in AR3634; and dynamic trailers coming and going in AR3635. Perhaps one of the more noteworthy developments was a possible tenuous Mt Wilson delta spot becoming visible in the central portion of AR3634 in the northeastern solar quadrant, with its Zurich classification being 'Dri'. The eastern limb is likely to harbour still more significant regions beyond view, with substantial arcing of the magnetic field between hemispheres (visible on AIA171 and 094, for example). This behaviour perhaps betrays the locations of successor regions to Ex-AR3614 and Ex-AR3615, both of which were major sunspot regions when last visible from Earth around a fortnight ago.

There were numerous Coronal Mass Ejections (CMEs) observed on available coronagraph imagery in the period. Of these, the most significant is thought to be a faint partial halo emitted from a filament eruption narrowly in the southwest quadrant and occurring around 12/0020UTC. This feature has been analysed by two successive forecasters, with both independently obtaining very similar results and suggesting an arrival early in the UTC day of Monday 15 April.

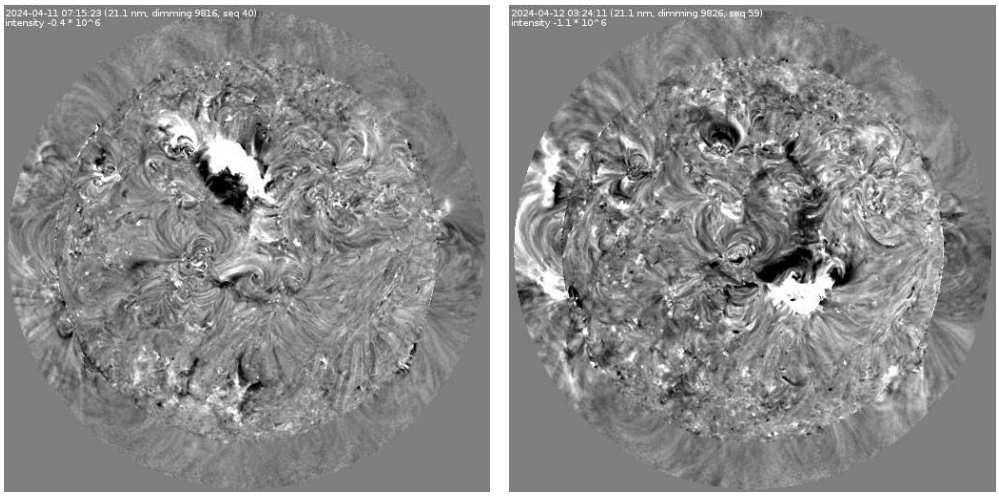

Figure 0 : SIDC ROB-processed AIA 211 dimmings of the two potentially inbound CME candidates. The first emanated from the northeast quadrant around 11/0530UTC (i.e. prior to this reporting period) and is due late in the UTC day of 14 April. The second was emitted from the southwest 12/0020UTC, and is potentially due very early in the UTC day of 15 April.

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Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, showed a slow regime. The solar wind speed decreased very slightly from 425 to nearer 400km/s, while the solar wind density remained near its long-term average in single-figures ppcc. The IMF was very steady at or below 5nT, while the north-south component ranged between +/-4nT with an erratic tendency. The phi angle was mostly positive (away from the Sun), but showed a change to negative after 12/2115UTC.

The net result of the above solar wind measures was for predominantly Quiet Kp indices, with a provisional peak of Kp 3- in the 09-12UTC interval.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at Background levels.

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background to Moderate levels, with a peak of 395pfu observed at 12/1455UTC. The associated 24-hour fluence remained below Active (1e8 integrated flux) with a value of 1.1e7 integrated pfu recorded at 13/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is Likely, largely the result of returning successor regions to Ex-AR3614 and Ex-AR3615 over the eastern solar horizon into the current UTC weekend. This trend is stable throughout, with no significant active region departures over the western limb, but the new daily level of risk may yet be adjusted once the new arrivals more fully present for analysis.

Solar Wind / Geomagnetic Activity: The main consideration for the forecast period is the prospect of up to two potential Earth-directed CMEs, although estimates have been slightly revised. The first, resulting from a filament eruption around 11/0540UTC, gives the potential for a glancing impact later on day two, Sunday 14 April. The second CME arises from the filament eruption from near centre-disc around 12/0020UTC, with a most likely arrival time for this feature early on 15 April.

The coronal hole-based forecast is expected to be the lesser contributor, with the onset of any fast wind from CH24/- most likely occurring later in the current UTC day (13 April) and on into 14 April.

Geomagnetic activity is forecast to increase from current mainly Quiet levels to perhaps become Active within the current UTC day and into Sunday 14 April. There is then a Chance of G1/G2 Minor/Moderate geomagnetic storms late in the UTC weekend and into the very start of the new UTC working week, with up to two CMEs inbound - especially if any arrivals combine. Activity should then ease back to mainly Quiet to Unsettled levels through day four (Tuesday 16 April).

Energetic Particles / Solar Radiation: High energy proton flux as observed by GOES18 is expected to persist at Background levels.

High energy electron flux at GOES16 is expected to temporarily decrease from a diurnal Moderate peak to Normal Background with the onset of any fast wind and then up to two CMEs, but presents a risk of rising by the end of the period to give a peak Chance of Active 24-hour integrated fluence by this time.

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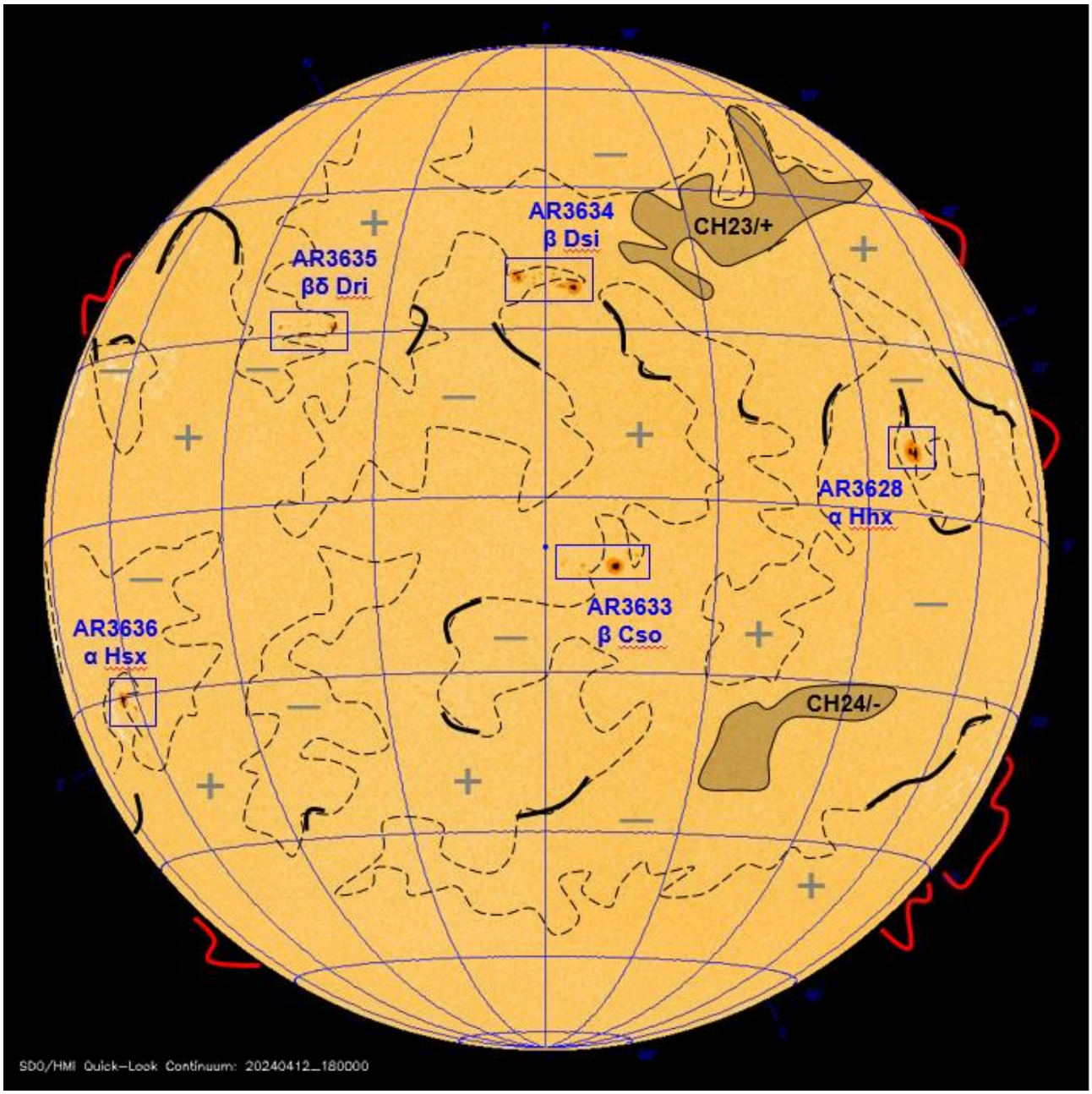
Figure 1. Solar Analysis Valid 12/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast comprises up to two CMEs and a relatively minor fast wind onset.

Regarding CMEs, there are up to two filament eruptions of note: the first is a re-evaluated CME from the north-centre filament eruption 11/0540UTC. Despite its original location in the northeast, this was seen as a faint partial halo to the southeast and is considered to have the potential to give a glancing impact late in the UTC day of Sunday 14 April. MOSWOC Enlil suggests a most likely arrival of 14/1900UTC, however this is likely to be on the early-end of estimates, as MOSWOC Enlil displayed a fictitious 600km/s fast wind in recent days that is only now waning in model-space, which will likely provide less of a brake on this CME than the actual 400km/s solar wind in observations.

The second and perhaps more noteworthy CME in the forecast is the filament eruption observed just southwest of centre-disc around 12/0020UTC. The subsequent CME is very faint, but perceptible on SOHO C2 and STEREO A difference imagery, as a full halo. This has been analysed twice, with very similar results being obtained in an arrival very early in the UTC day of Monday 15 April. This CME will also likely suffer the same modelling discrepancy as the first, and the MOSWOC Enlil suggested arrival of 15/0100UTC is probably on the fast end of probable arrival estimates. This is the main reason for the late-skewed Likely G1/G2 over the two UTC days of 14 and 15 April, with activity perhaps peaking later in the UTC night separating the two days.

The fast wind forecast is very likely to be the minor factor in the geomagnetic forecast overall. A most likely arrival of the fast wind from CH24/- is mooted for later in the UTC day of Saturday 13 April, continuing over the remainder of the weekend before CME influence likely comes to dominate. This is a recurrent feature, with 450km/s observed last rotation, while negative coronal holes are also still favoured for connection. However confidence is low due to the lack of notable enhancement observable in Enlil, besides the potential CME glance.

All considered, initially Quiet geomagnetic activity may increase to Active within the current UTC day, before more sharply increasing to round out the UTC weekend with the closely-spaced arrival of the 11/0540UTC filament and then the 12/0020UTC filament late on 14 and early on 15 April. Activity should have largely waned into the final day of the four, with Quiet conditions reinstated before midweek UTC.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	50	70	5
Strong	G3	No	1	10	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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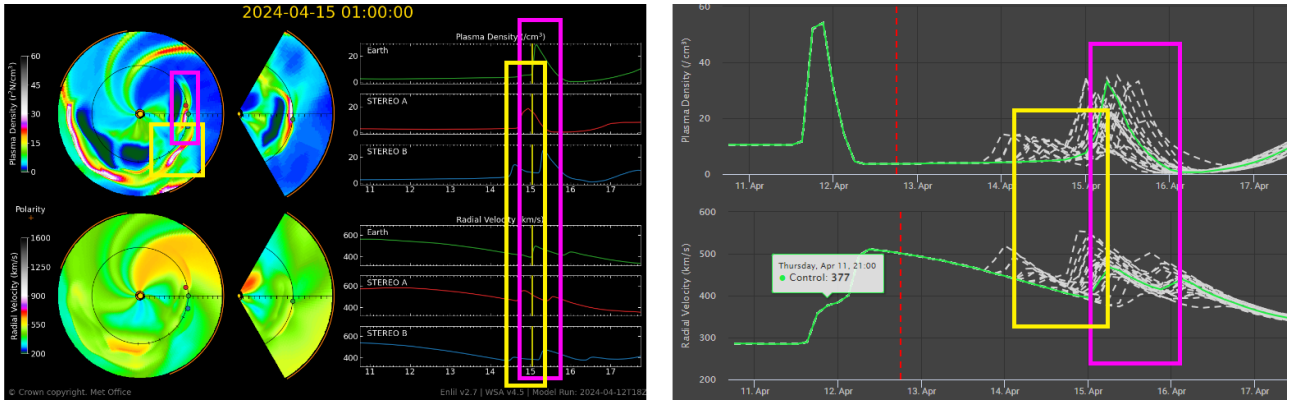
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0620	Full	Filament eruption	SW	670	Early UTC day 15 April	Fuller hit expected
11/0540	Partial	Filament eruption	NE	856	Late UTC day 14 April	Glancing blow, despite emission location

Figure 2: Latest MOSWOC Enlil run (badge time 12/1800UTC) and ensemble, showing the 11/0530UTC filament in yellow and the 12/0020UTC filament in magenta. Note that Enil is displaying a long tail of a misrepresented fast wind that was modelled to peak at 600km/s into the start of this run – this is overly-fast and will offer less of a brake to the inbound CMEs that the actual interplanetary medium, and the arrivals shown are therefore more likely on the quicker end of arrival time probabilities.



Radio Blackouts - X-Ray Flares:

Solar activity is now Likely to rise to become Moderate, with the exact level uncertain until up to two large and previously active returning regions present over the eastern solar horizon in the current UTC weekend. The analysable disc is by contrast a relatively minor component of this risk, with two unipolar regions and three relatively stable and simple bipolar regions. No significant departures are therefore expected in the four days, and the successor regions to both Ex-AR3614 and Ex-AR3615 will likely dominate proceedings for many days yet.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: AIA171 imagery from 12/2300UTC showing oncoming eastern solar horizon, likely harbouring successor regions to Ex-AR3615 and Ex-AR3614. Also shown is SIDC ROB visualisation

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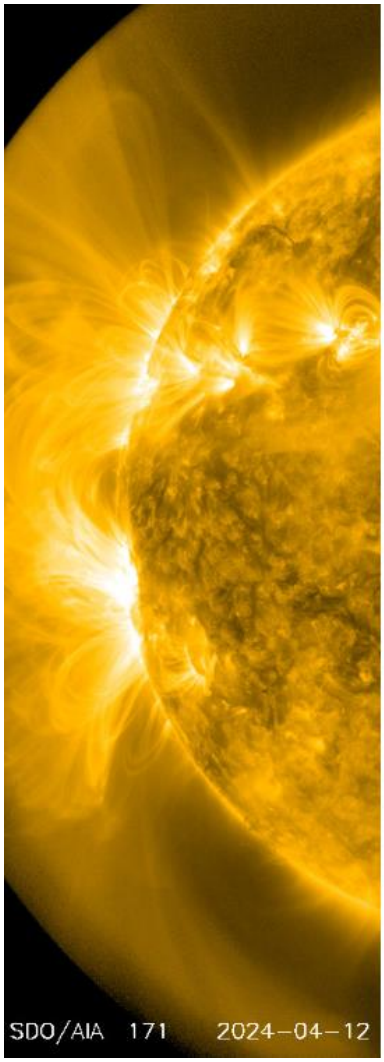
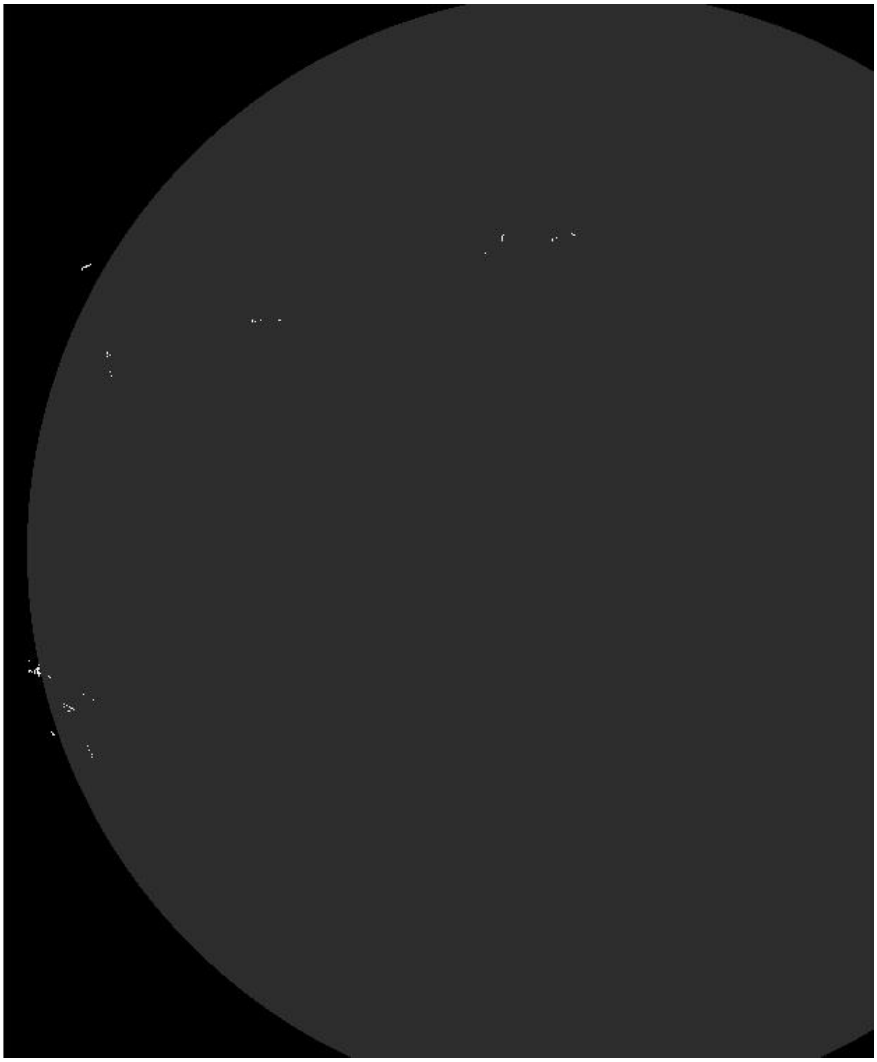
of C-class flares and above in the past 24 hours, as recorded at PROBA2. Note the large contribution from the limb.





Solar Radiation Storms - (High Energy Protons):

High energy proton flux as observed by GOES18 has remained at Background levels. Solar radiation storms are currently not expected, given the lack of active sunspot regions either on or moving into in the western portion of the disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):

High energy electron flux at GOES16 is expected to temporarily decrease from a diurnal Moderate peak to Normal Background with the onset of any fast wind and then up to two CMEs. The extent of any rebound at GEO is uncertain by the end of the coming four-day period, but perhaps shows a peak Chance of Active 24-hour integrated fluence by this time.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	1	5	30
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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